PROJECT

SAFETY ANALYSIS

HUMAN FACTORS AND ORGANIZATIONAL ISSUES IN CONTROLLED FLIGHT INTO TERRAIN (CFIT) ACCIDENTS

1984 - 1994

Controlled flight into terrain (CFIT)
Human Factors and Organizational Issues

1. This is an update on the activities of the International Civil Aviation Organization (ICAO) Air Navigation Bureau (ANB) with respect to controlled flight into terrain (CFIT) ocurrences, within the context of its Flight safety and Human factors Programme.

2. Since October 1993, the ANB has reviewed and analyzed data available from official sources in an attempt to identify the Human Factors and organizational issues underlying CFIT occurrences. The review has produced the data which is attached. The attachment also includes a description of the methodology used by the ANB in conducting the analysis of the data.

3. The accidents selected for analysis involved commercial air transport turboprop/ turbojet aircraft accidents investigated by States between 1984 and 1994, independent of aircraft mass or seating capacity. The data gathered reflects factual data extracted from the States' official investigation reports, without inferences or assumptions by the Secretariat. The purpose of the analysis was to determine whether there exists a set of human performance issues involved in CFIT accidents which consistently emerge from official investigation reports. This analysis applied the Reason Model (succinctly discussed in the attachment) in an attempt to define the "anatomy" of a CFIT accident from the perspective of Human Factors.

4. It has been a fundamental premise of the ICAO Flight Safety and Human Factors programme since its inception that operational personnel performance does not take place in a social vacuum, but within operational contexts which either resist or foster inherent human weaknesses and flaws. This became obvious as the analysis of the official accident reports progressed. Lapses in human performance were cited in all CFIT reports analyzed. All the reports also disclosed flaws and deficiencies in the aviation system which adversely affected human performance in the particular circumstances under which accidents occurred.

5. The analysis thus discloses a dual pathway leading to CFIT accidents: an "active" pathway, generated by actions or inactions of front-line operational personnel (i.e., pilots, controllers, mechanics and so forth) ; and a "latent" pathway, generated by deficiencies in various aspects of the aviation system, for which managers and decision-makers are responsible.

6. The data indicates a preponderance of the "latent pathway" (approximately 88%), over the "active pathway", (slightly above 12%), in the genesis of CFIT occurrences. Figure 2 in the attachment provides an integrated picture of the Human Factors and organizational issues underlying CFIT occurrences. Figures 2 through 7 present a breakdown of the data obtained from the analysis.

7. The ANB intends to establish further correlations among this data. Likewise, the Secretariat will distribute this information among selected parties, including the Flight Safety and Human Factors Study Group, in an attempt to obtain feedback to further the analysis in depth. The analysis nevertheless clearly suggests the multi-dimensional aspects of Human Factors in CFIT accidents. This reaffirms the need for a systemic, collective approach to safety and prevention.

1. Sources of data

1.1 All accident information examined was extracted from the official investigation reports produced by the States' safety agencies. The list of aviation accidents included in the study comprises the following.

Aircraft Occurrence Report, Nahanni Air Services Ltd. de Havilland of Canada DHC-6-100 C-FPPL, Fort Franklin, Northwest Territories, 9 October 1984. Report Number 84-H40004

Aviation Occurrence Report, Labrador Airways Ltd. de Havilland of Canada DHC-6-100 C-FAUS, Goose Bay, Labrador, Newfoundland, 11 October 1984. Report Number 84-H40005

Aviation Occurrence Report, Simpson Air Ltd., Beechcraft King Air B-90 C-GDOM, Fort Simpson Airport, Northwest Territories, 16 October 1988. Report Number A 88W0234

Aircraft Accident Report, Embraer 110 Bandeirante, OH-EBA, in the vicinity of Ilmajoki Airport, Finland, November 14, 1988. Major Accident Report NO. 2/1988, Helsinki, 1990. Ministry of Justice, Ilmajoki Aircraft Accident Investigation Board

Aviation Occurrence Report, Voyageur Airways Ltd. Beechcraft King Air A-100 C-GJUL, Chapleu, Ontario, 29 November 1988. Report Number 8800491

Aviation Occurrence Report, Air Creebec Inc., Hawker Siddeley HS 748-2A C-GQSV, Waskaganish, Quebec, 3 December 1988. Report Number A88Q0334

Aircraft Accident Report, Fairchild Swearingen Merlin III SA226T, N26RT, Helsinki-Vantaa Airport, Finland, February 23, 1989. Accident report No. 1/1989, Helsinki, 1989. Ministry of Justice, Planning Commission for the Investigation of Major Accidents

Aviation Occurrence Brief, Ptarmigan Airways Ltd., Piper PA-31T Cheyenne C-GAMJ, Hall Beach, Northwest Territories, 17 April 1989. Brief Number A89C0069

Aviation Occurrence Report, Skylink Airlines Ltd., Fairchild Aircraft Corporation SA227 Metro III C-GSLB, Terrace Airport, British Columbia, 26 September 1989. Report Number 89H0007

Aircraft Accident Report, Aloha Islandair, Inc.. Flight 1712, de Havilland Twin Otter, DHC-6-300, N707PV, Halawa Point, Molokai, Hawaii, October 28, 1989

Report on the Accident to Indian Airlines Airbus A-320 Aircraft VT-EPN on 14th February, 1990 at Bangalore. Government of India, Ministry of Civil Aviation.

Aviation Occurrence Report, Frontier Air Ltd., Beechcraft C99 Airliner C-GFAW, Moonsonee, Ontario, 30 April 1990. report Number A90H0002

Accident Investigation Report, Beech King Air E90 VH-LFH, Wondai, Queensland, 26 July 1990. BASI Report B/901/1047

Final report of the Federal Aircraft Accidents Inquiry Board concerning the Accident of the aircraft DC-9-32, ALITALIA. Flight No. AZ404, I-ATJA on the Stadlerberg, Weiach, 14 November 1990

Table 1. Organizational processes

Goal-setting	Communicating
Policy-making	Designing/specifying
Organising	Purchasing
Forecasting	Supporting
Planning	Researching
Scheduling	Marketing
Managing operations	Selling
Managing maintenance	Information-handling
Managing projects	Motivating
Managing safety	Monitoring
Managing change	Checking
Financing	Auditing
Budgeting	Inspecting
Allocating resources	Controlling

2.1.2 Defences, barriers and safeguards

These are measures aimed at removing, mitigating or protecting against operational personnel hazards. They serve different functions and present different modes of application. Table 2 introduces a classification of defences, barriers and safeguards.

2.1.2.1 Corporate culture

A set of beliefs, values, norms and assumptions that the organization makes about itself, the nature of people in general and its environment. A set of unwritten rules that govern acceptable behaviour within and outside the organization ("The way we do business here"). Although not a distinct component of the model employed as analytical tool, corporate culture deserves a special mention, since it has been recognized by recent research undertaken by organizational psychology as one of the most important and effective barriers against hazards and safety breakdowns in high-technology systems.

Table 2. Defences, barriers and safeguards

Modes of application

- Engineered safety devices (automatic detection and shutdown, etc.)
- Policies standards and controls (administrative and managerial measures designed to promote standardised and safe working practices–together they constitute the safety management system and have as their adjuncts techniques (cause-consequence analyses, etc.)
- Procedures, instructions and supervision (measures aimed at providing local task-related know how).
- Training, briefing, drills (the provision and consolidation of safety awareness and safety knowledge).
- Personal protective equipment (anything from safety boots to space suits).

2.1.3 Latent Failures

Decisions taken in the managerial and organizational spheres. These are people separated in time and space from the operational interface. Latent failures are originated in flawed organizational processes which break though systems defences, barriers and safeguards. Latent failures may remain undetected for considerable periods of time, before they combine with active failures and local triggers to generate an accident.

2.1.4 Local working conditions

These are the factors that influence the efficiency and reliability of human performance in a particular work context. Table 3 and 4 present a breakdown of local working conditions and list the principal factors.

Table 3. Situational and task factors

Error factors	Common factors	Violation factors
Change of routine	Time shortage	Violations condoned
Negative transfer	Inadequate tools and equipment	Compliances goes unrewarded
Poor signal-noise ratio	Poor procedures and instructions (ambiguous or inapplicable)	Procedures protect system not person
Poor human-system interface	Poor tasking	Little or no autonomy
Poor feedback from system	Inadequate training	Macho culture
Designer-user mismatch	Hazards not identified	Perceived licence to bend rules
Educational mismatch	Undermanning	Adversarial industrial climate (them and us)
Hostile environment	Inadequate checking	Low pay
Domestic problems	Poor access to job	Low status
Poor communications	Poor housekeeping	Unfair sanctions
Poor mix of hands-on work and written instructions (i.e., too much reliance on knowledge in the head)	Bad supervisor/worker ratio	Blame culture
	Bad working conditions	Poor supervisory example
Poor shift patterns and overtime working	Inadequate mix of experience and inexperienced workers	Tasks affording easy shortcuts

Local working conditions (cont.)

Table 4. Personal factors

Error factors	Common factors	Violation factors
Attentional capture	Insufficient ability	Age and gender
Preoccupation	Inadequate skill	High risk target
Distraction	Skill overcomes danger	Behavioural beliefs
Memory failures	Unfamiliarity with task	(gains outweigh risks)
Encoding interference	Age-related factors	Subjective norms
Storage loss	Poor judgement	condoning violations
Retrieval failure	Illusion of control	Perceived behavioural
Prospective memory	Lease effort (cognitive	control
Strong motor programs	economics)	Personality
Frequency bias	Overconfidence	Non-compliant
Similarity bias	Performance anxiety	Unstable extravert
Perceptual set	(deadline pressures)	Low morale
False sensations	Arousal state	Bad mood
False perceptions	Monotony & boredom	Job dissatisfaction
Confirmation bias	Emotional stress	Attitudes to system
Situational unawareness		Management
Incomplete knowledge		Supervisors
Inaccurate knowledge		Discipline
Inference & reasoning		Misperception of hazards
Stress & fatigue		Low self-esteem
Disturbed sleep patterns		Learned helplessness
Error proneness		

2.1.5 Active Failures

Errors and violations committed by operational personnel, the consequences of which are revealed immediately and have an immediate impact.

2.1.6 Local triggers

Technical failures, adverse weather conditions or any other particular (i.e., *local*) atypical/abnormal system operating conditions.

FIGURE 1

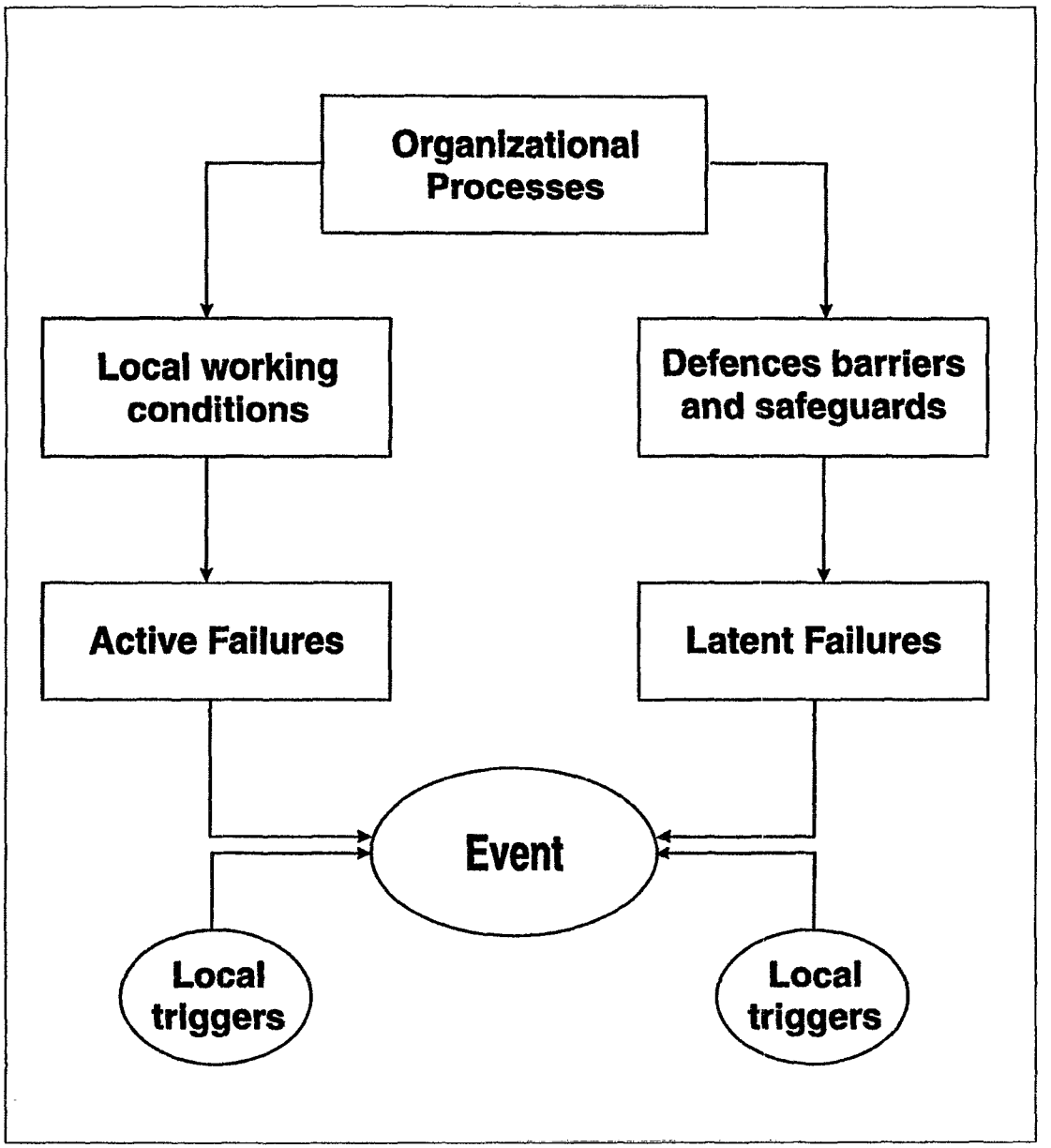

Organizational Processes
Local working conditions
Defences barriers and safeguards
Active Failures
Latent Failures
Event
Local triggers
Local triggers

FIGURE 2

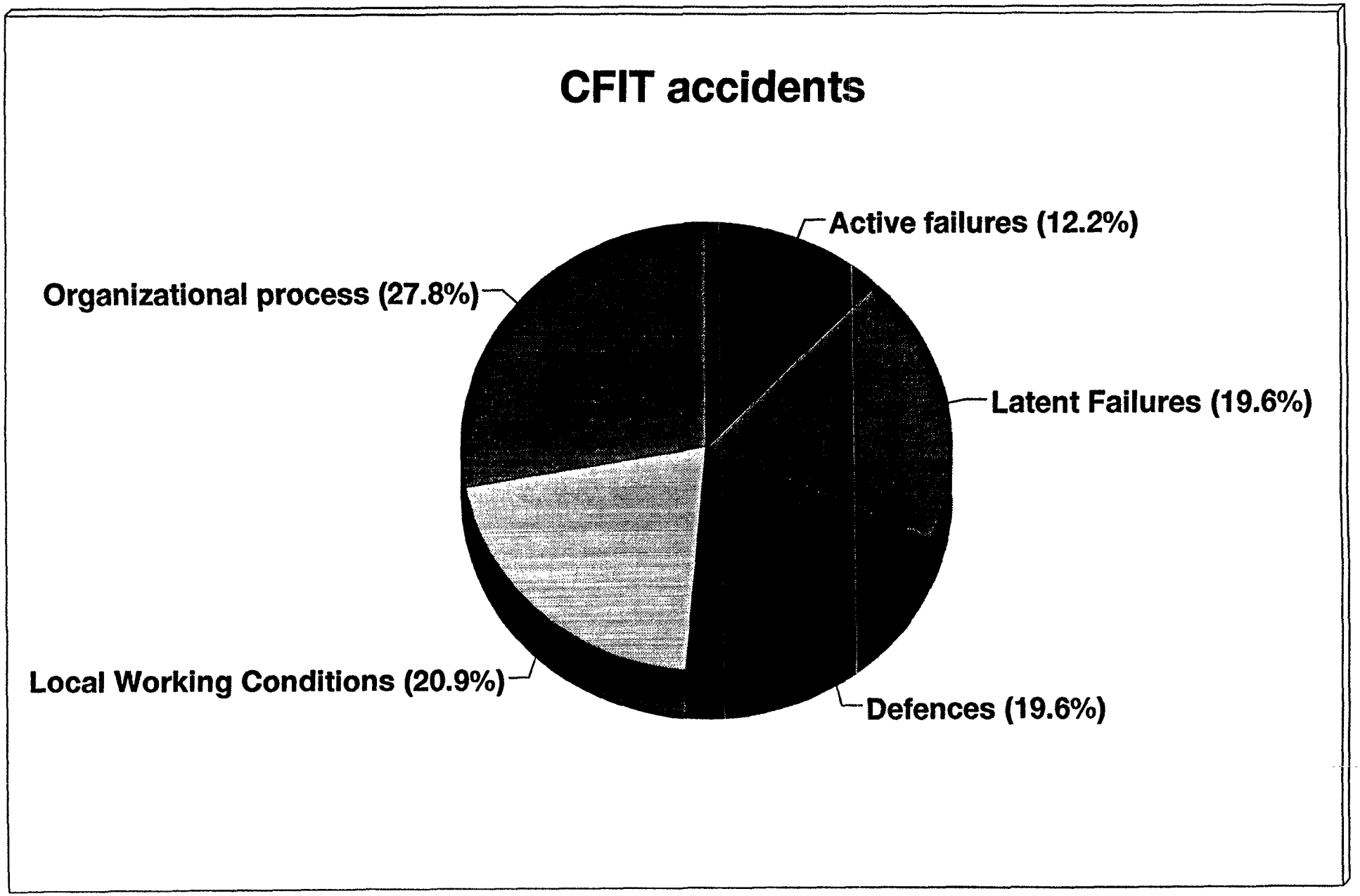

CFIT accidents
Active failures (12.2%)
Latent Failures (19.6%)
Defences (19.6%)
Local Working Conditions (20.9%)
Organizational process (27.8%)

FIGURE 3

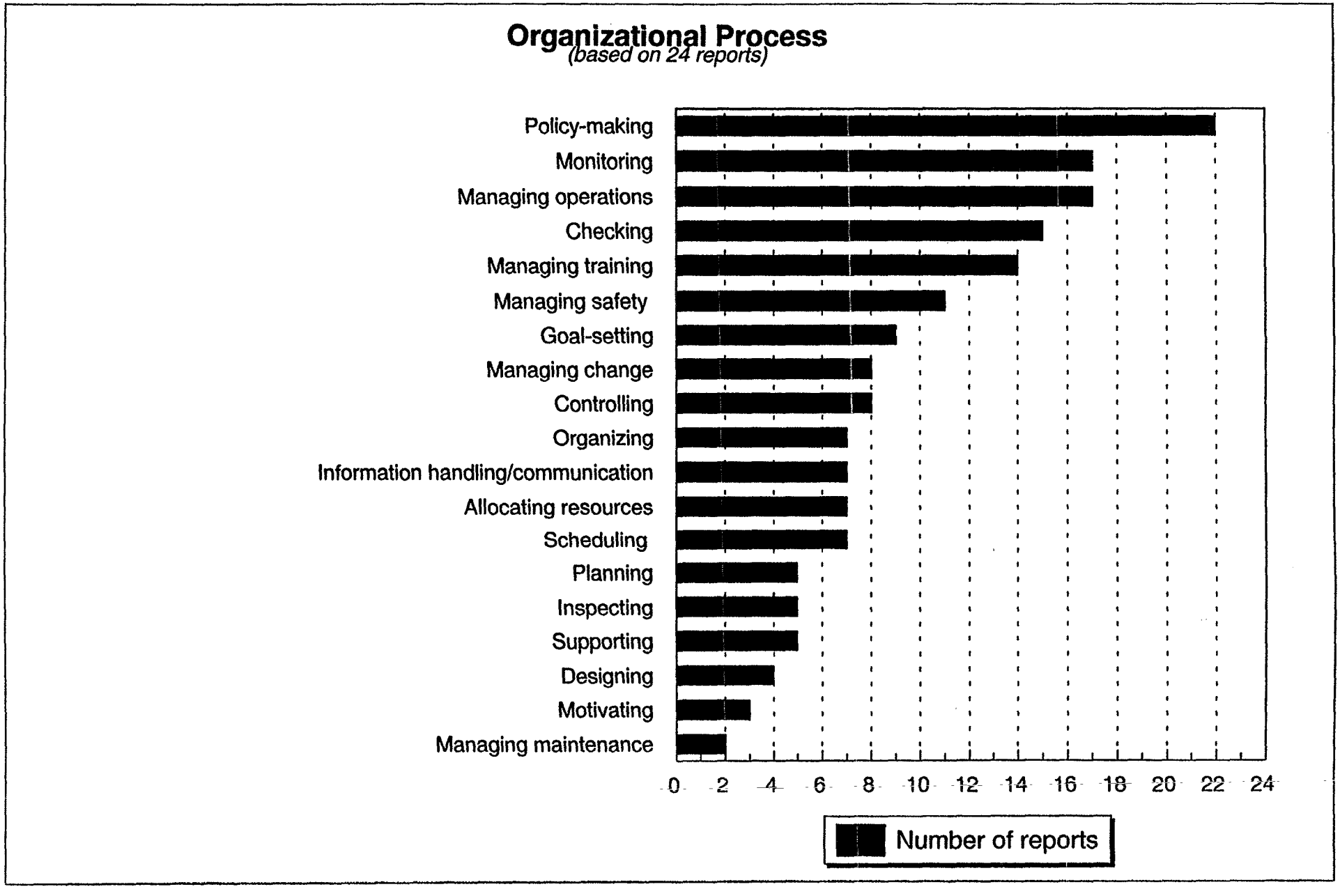

Organizational Process
(based on 24 reports)
Policy-making
Monitoring
Managing operations
Checking
Managing training
Managing safety
Goal-setting
Managing change
Controlling
Organizing
Information handling/communication
Allocating resources
Scheduling
Planning
Inspecting
Supporting
Designing
Motivating
Managing maintenance
0 2 4 6 8 10 12 14 16 18 20 22 24
Number of reports

FIGURE 4

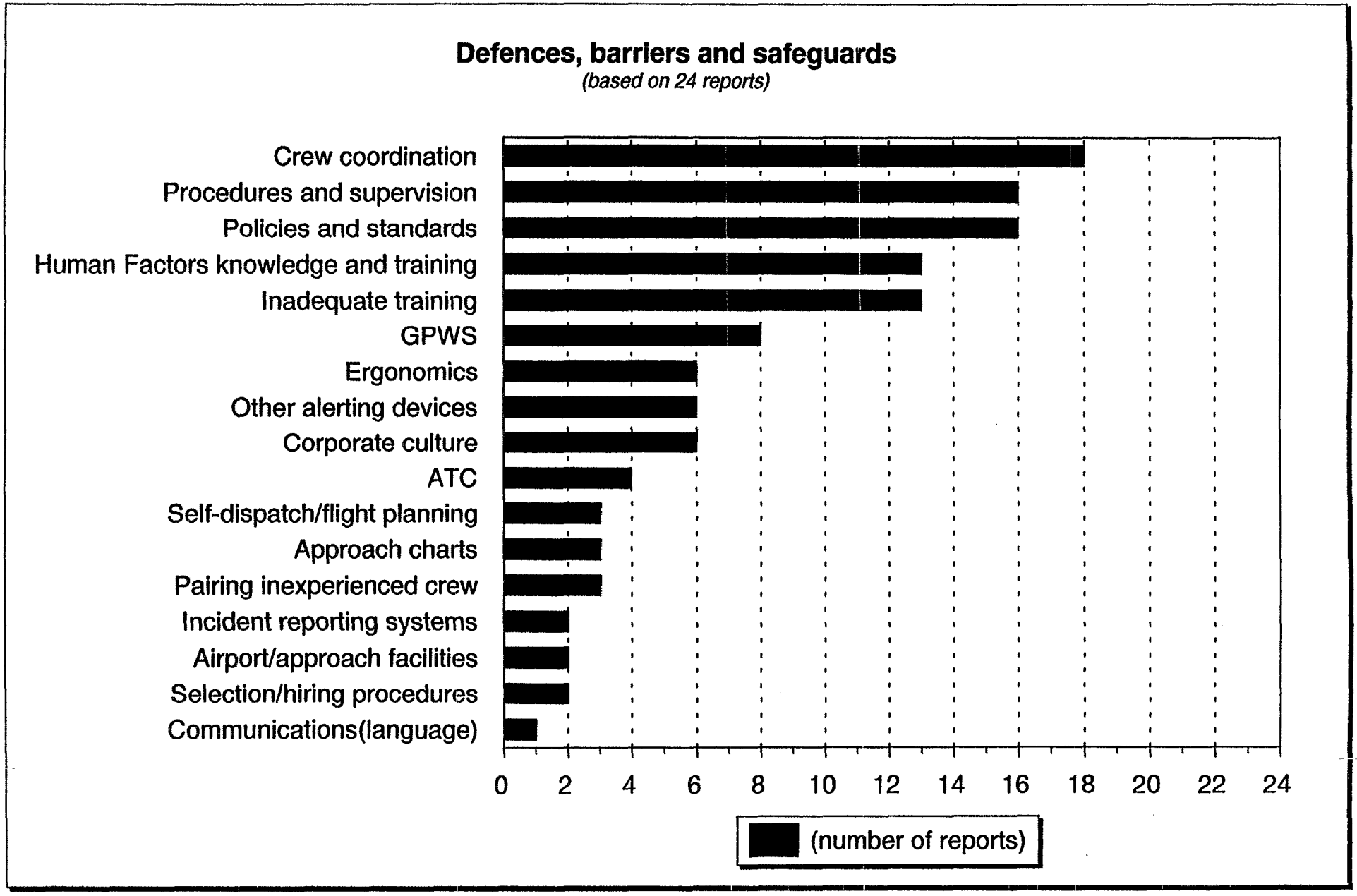

Defences, barriers and safeguards
(based on 24 reports)
Crew coordination
Procedures and supervision
Policies and standards
Human Factors knowledge and training
Inadequate training
GPWS
Ergonomics
Other alerting devices
Corporate culture
ATC
Self-dispatch/flight planning
Approach charts
Pairing inexperienced crew
Incident reporting systems
Airport/approach facilities
Selection/hiring procedures
Communications(language)
0 2 4 6 8 10 12 14 16 18 20 22 24
(number of reports)

FIGURE 5

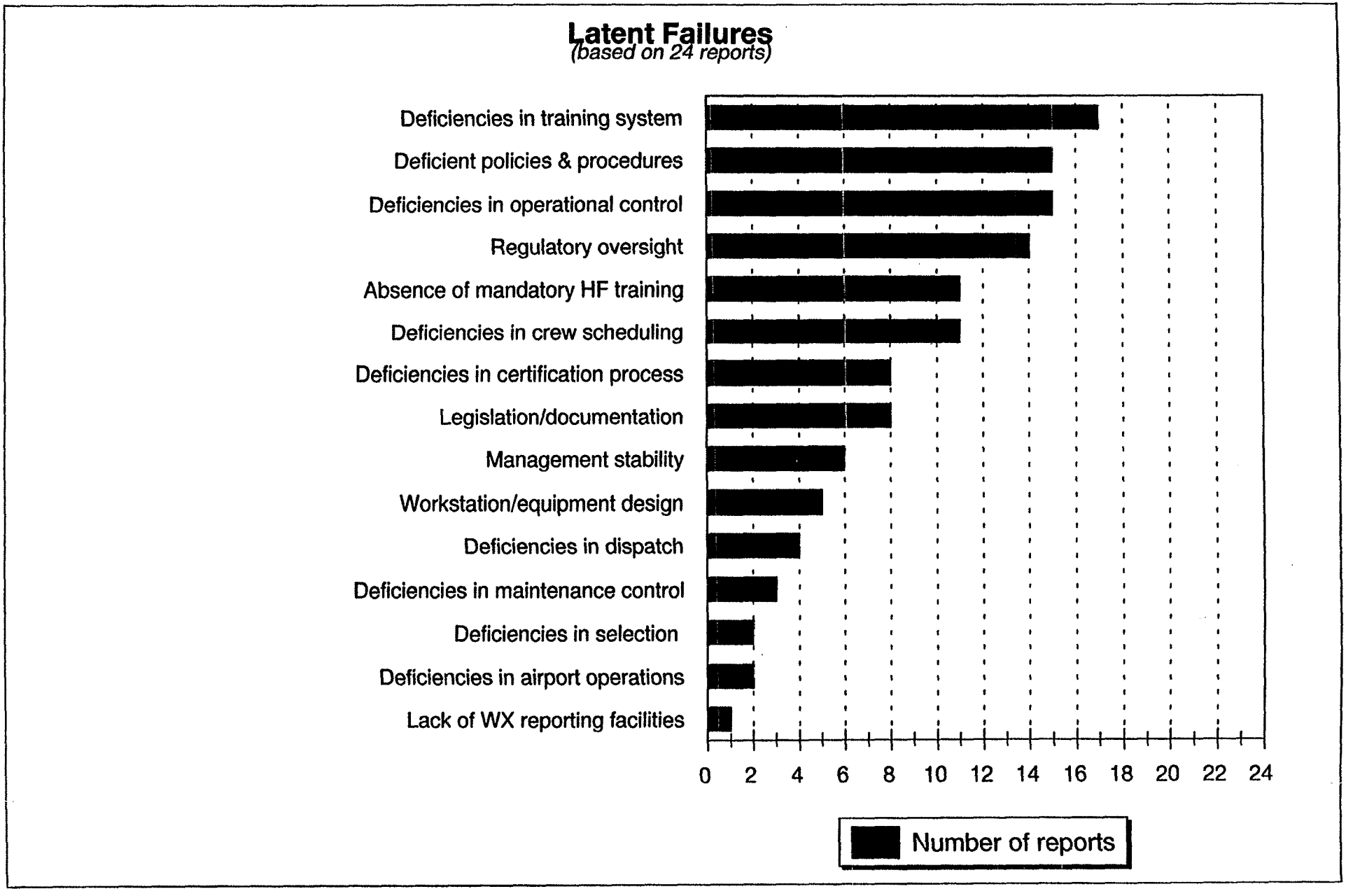

Latent Failures
(based on 24 reports)
Deficiencies in training system
Deficient policies & procedures
Deficiencies in operational control
Regulatory oversight
Absence of mandatory HF training
Deficiencies in crew scheduling
Deficiencies in certification process
Legislation/documentation
Management stability
Workstation/equipment design
Deficiencies in dispatch
Deficiencies in maintenance control
Deficiencies in selection
Deficiencies in airport operations
Lack of WX reporting facilities
0 2 4 6 8 10 12 14 16 18 20 22 24
Number of reports

FIGURE 6

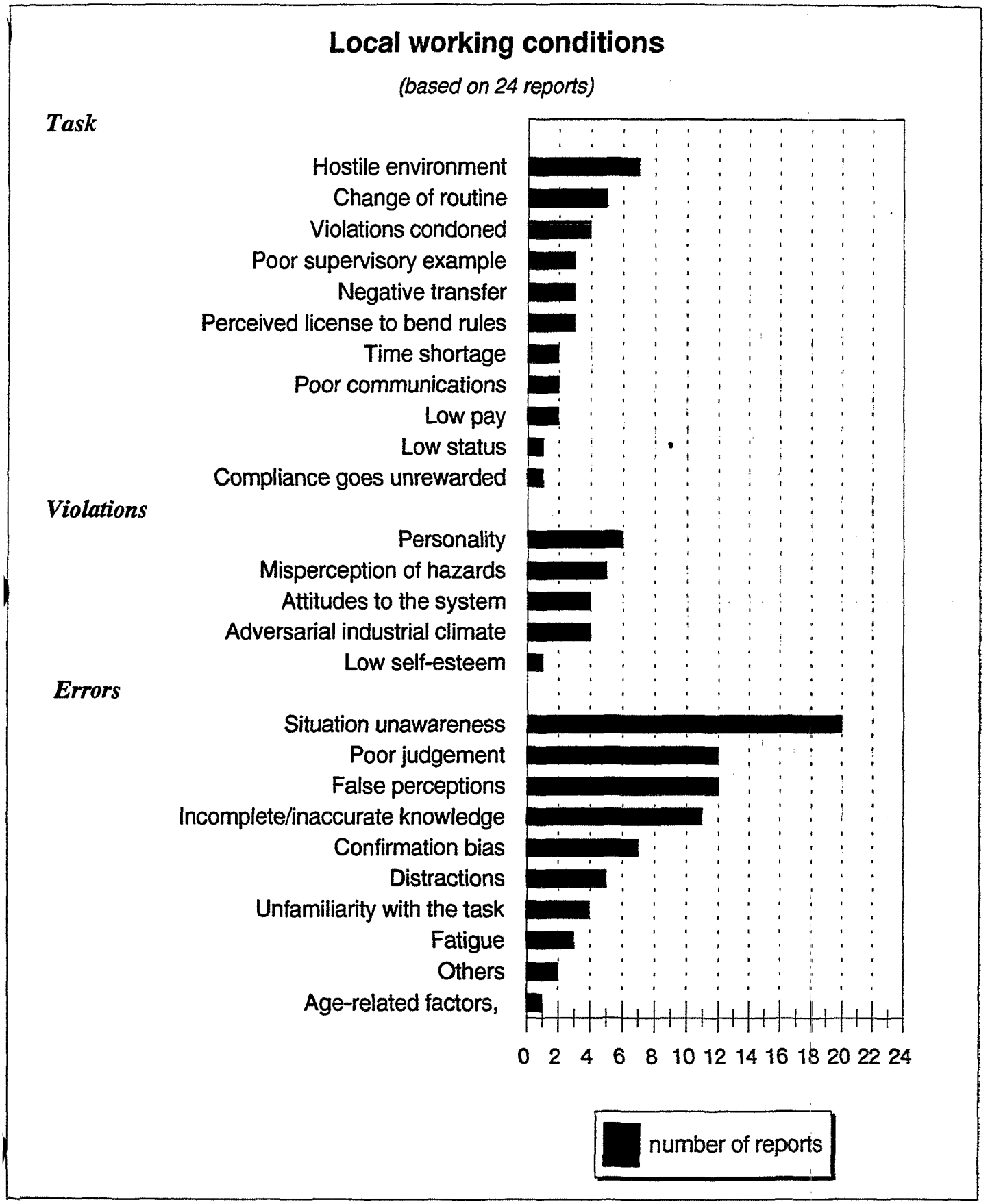
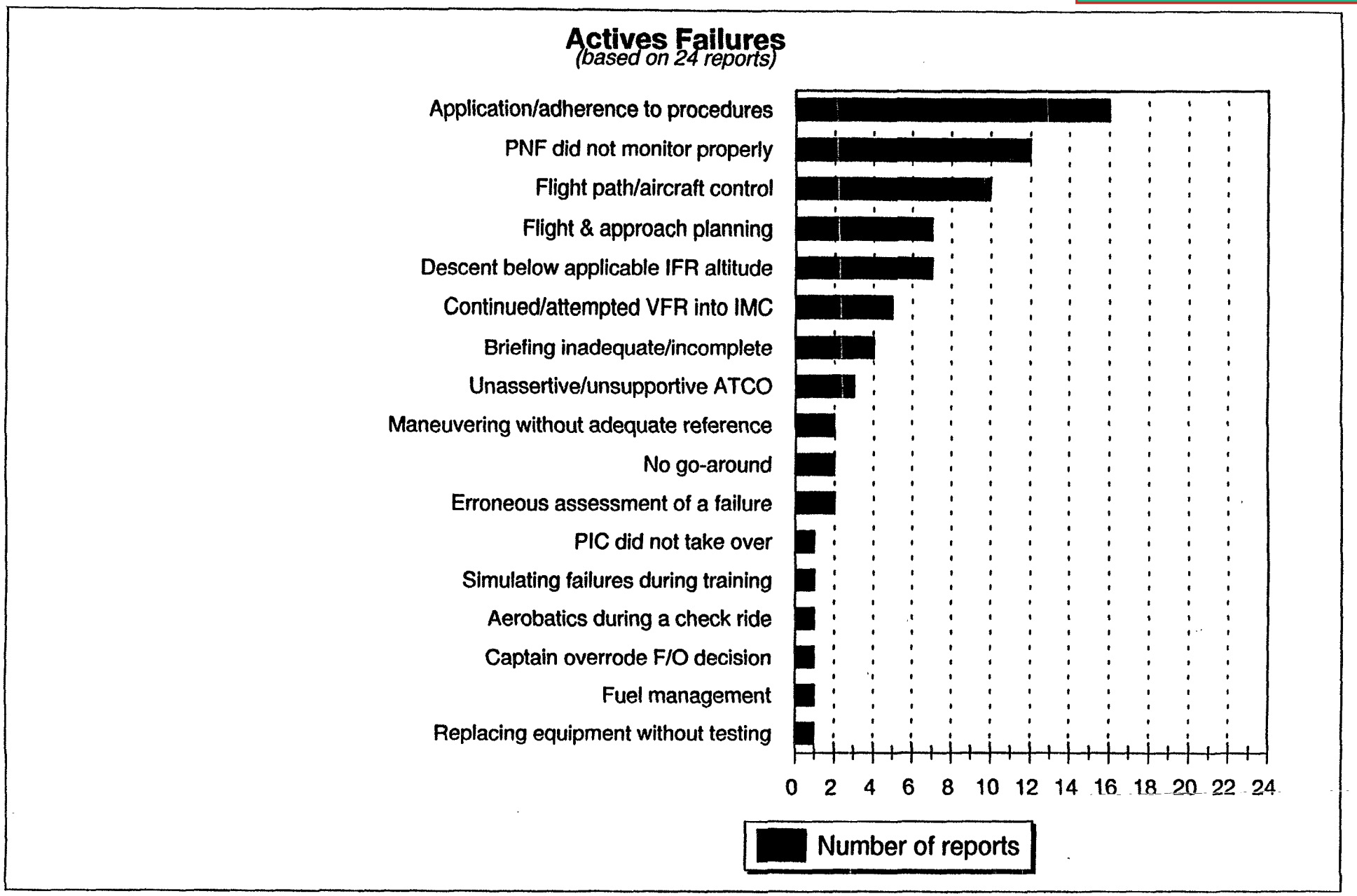

Local working conditions
(based on 24 reports)
Task
Hostile environment
Change of routine
Violations condoned
Poor supervisory example
Negative transfer
Perceived license to bend rules
Time shortage
Poor communications
Low pay
Low status
Compliance goes unrewarded
Violations
Personality
Misperception of hazards
Attitudes to the system
Adversarial industrial climate
Low self-esteem
Errors
Situation unawareness
Poor judgement
False perceptions
Incomplete/inaccurate knowledge
Confirmation bias
Distractions
Unfamiliarity with the task
Fatigue
Others
Age-related factors,
0 2 4 6 8 10 12 14 16 18 20 22 24
number of reports

FIGURE 7


Actives Failures
(based on 24 reports)
Application/adherence to procedures
PNF did not monitor properly
Flight path/aircraft control
Flight & approach planning
Descent below applicable IFR altitude
Continued/attempted VFR into IMC
Briefing inadequate/incomplete
Unassertive/unsupportive ATCO
Maneuvering without adequate reference
No go-around
Erroneous assessment of a failure
PIC did not take over
Simulating failures during training
Aerobatics during a check ride
Captain overrode F/O decision
Fuel management
Replacing equipment without testing
0 2 4 6 8 10 12 14 16 18 20 22 24
Number of reports

- END -